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Ruhland, G., Fischer, G. and cruise participants

REPORT AND PRELIMINARY RESULTS OF POSEIDON CRUISE 365 (LEG 1+2)

Leg 1: Las Palmas – Las Palmas
13.04.2008 – 16.04.2008

Leg 2: Las Palmas – Las Palmas
18.04.2008 – 29.04.2008

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Report and preliminary results of R/V POSEIDON Cruise 365 (Leg 1+2). Leg 1: Las Palmas - Las Palmas, 13.4. - 16.4.2008. Leg 2: Las Palmas - Las Palmas, 18.4. - 29.4.2008.

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Contents: Leg 1 and 2

1. Narrative

RV Poseidon left the port of Las Palmas in the morning of April 13th, 2008 towards the DOLAN buoy position in the north of the island of Tenerife. In the afternoon the PACT mooring close to the buoy was successfully recovered. Afterwards a CTD cast for post-calibration had been done. The next morning (April 14th) the recovery of the whole buoy mooring was started. This work could be finished at noon. Due to the fact that the project time ended, the buoy was not redeployed. The ship steamed towards the ESTOC monthly monitoring position. On the way, an XBT was launched. In the late afternoon, the two CTD casts for the monthly monitoring were done. Overnight the ship steamed to the ESTOC sediment trap mooring. On April 15th this mooring was released and successfully recovered. All three particle traps provided full sets of sample bottles. At noon, a CTD cast to 800 m water depth was launched. Afterwards a NOAA drifter was deployed. At 14:00h ESTOC sediment trap mooring was redeployed after maintenance. Overnight, RV Poseidon steamed back to Las Palmas and arrived there in the morning of April 16th.

RV Poseidon left the port of Las Palmas (Gran Canaria) on April, 18, 2008 at 8:30 pm for Leg 2 sailing in southwesterly direction to the study area off Cape Blanc (Mauritania). We planned to perform biogeochemical, marine-chemical, microbial and micropaleontological studies off Cape Blanc as well as the exchange of two sediment trap moorings which were deployed during RV MERIAN cruise the year before. Additionally, a particle camera was planned to be launched to measure the distribution and size of marine snow aggregates. The ROV *Cherokee* was scheduled to be deployed for the observation of larger particles in the water column.

On Sunday, 20th of April, we reached the first study site about 200 nm off Cape Blanc at about 21°17.N and 20°49.W. Here, we recovered the sediment trap mooring CB-18 within three hours; all instruments had worked. The study site is located at the edge of the coastal upwelling filament off Cape Blanc. After launching the rosette with the shipboard SBE-3-CTD (additionally equipped with oxygen and chlorophyll sensors) to 800 m water depth, the particle camera ParCa with a SBE-19 CTD (with oxygen and chlorophyll fluoerescence sensors) was launched to 2000 m water depth. On early monday morning, April 21, a deep rosette-CTD station to 2000 m was performed. The new sediment trap mooring CB-19 was then redeployed on the former position of CB-18 within two hours.

We then sailed to the second station having increasingly bad weather with strong winds and a high swell from the north. Therefore, we only launched an XBT to 1800 m water depth. We sailed further eastwards crossing station 3 (mooring site CBi-5) and finally decided to launch a shallow rosette-CTD down to 700 m at station 4 (about 20°44.N, 18°W). During the night, we moved back to the mooring site CBi-5/6 (station 3). After deploying a ParCa-CTD to 2500 m water depth, we decided to release the mooring CBi-5 on Wednesday morning, April 23, during relatively rough weather conditions. The upper MSD trap with 40 sample containers had worked perfectly, the lower trap had failed. Lateron, we sailed to the south to station 5, launching an XBT to 1800 m, a shallow rosette-CTD to 800 m as well as a ParCa-CTD to 2500 m. During the night we moved northwards to the mooring site CBi-5/6. In the early morning of Thursday, April 24, we deployed a shallow and a deep rosette-CTD. As the weather improved, we could deploy the new mooring CBi-6 in the afternoon, now equipped with an additional MSD platform with an FSI-CTD and a video camera system. This system should record the particle distribution and transport over an annual cycle. Additionally, a high resolution MSD sediment trap with 40 cups was deployed in the upper part water column, the lower water column will be sampled by a classical 20-cup sediment trap. In the afternoon, we sailed to station 4 to launch the ParCa-CTD to 750 m water depth. Afterwards, we sailed northwards to station 7. As the wind and the swell further decreased, we were able to deploy the ROV *Cherokee* for about 5 hours. We studied four water levels at about 50, 100, 250 and 400 m water depths for the estimation of *in situ* particle settling rates using the settling chamber which is mounted to the ROV. The new settling chamber worked perfectly. The station work was completed with a shallow rosette-CTD and the ParCa-CTD down to 2000 m. Late Friday night, April 25th, we sailed northwards to Las Palmas, Gran Canaria. We reached Las Palmas earlier as planned in the early Monday morning of April 28th, 2008.

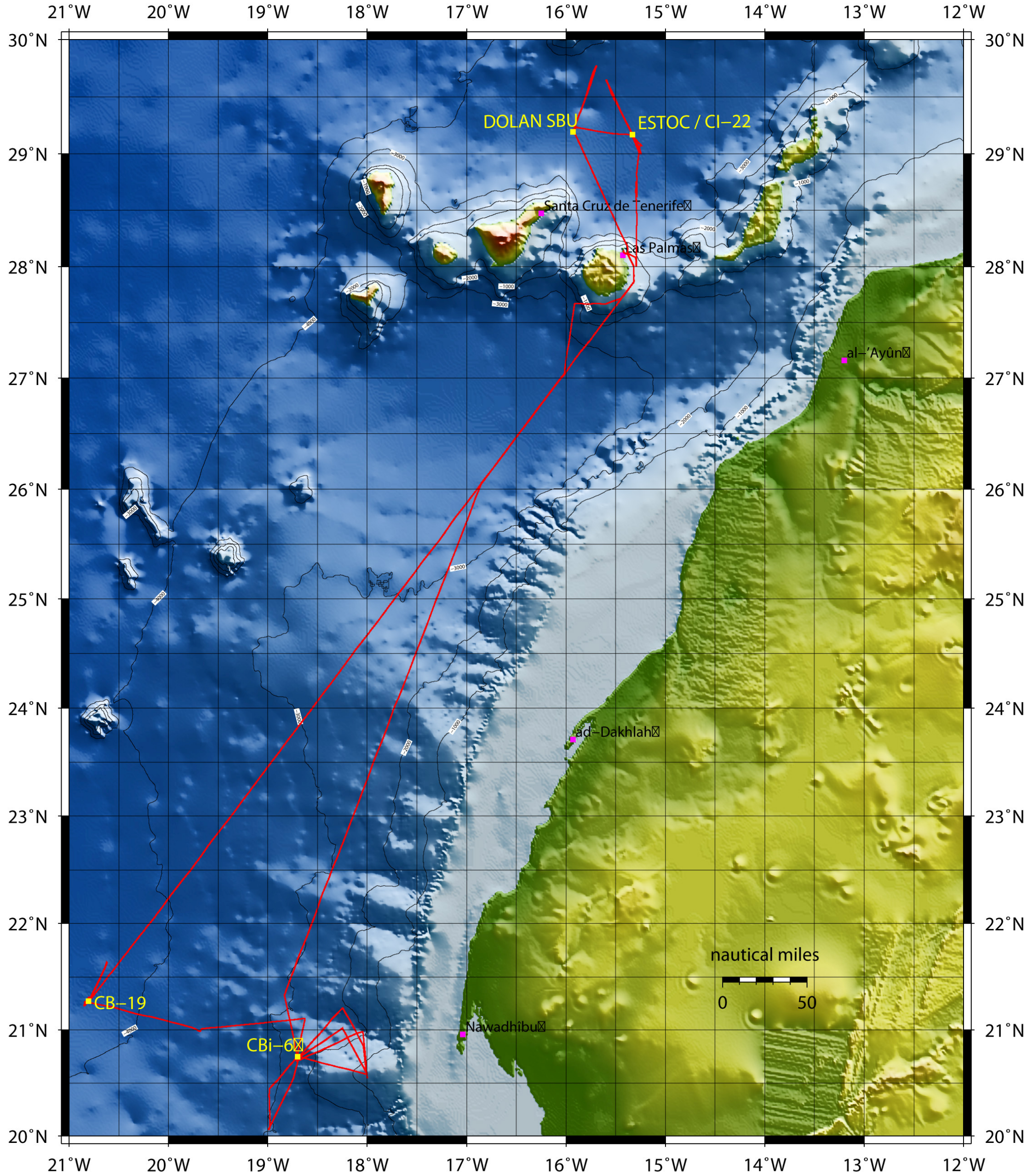


Fig. 1. Cruise track of POS 365 (Leg 1 and 2). The location of the DOLAN buoy and the sediment trap moorings CI/ESTOC, CBi and CB are also shown.

2. Preliminary Results

2.1. Atmospheric Sciences

2.1.1. Aerosol sampling *(Inka Meyer)*

Terrigenous sediments deposited in marine sediments are a mixture of a pelagic component brought in by the wind and a hemipelagic component supplied by rivers and from the shelf. The analysis of eolian dust allows the estimation of aridity in eolian source regions and the intensity of the transporting winds through grain-size measurements. Eolian dust can be used to reconstruct changes in continental climate. For validating the terrigenous sediment fraction in marine sediment cores, present-day dust samples were collected during the cruise.

The collecting was done with two dust-collectors which were placed on the observation deck. An engine inside both dust-collectors sucks the surrounding air. This air passes through a filter in which the dust is collected. The dust-collectors are connected with a vane to prevent that particles from the funnel reach the filters. If the dust collectors have no connection with the sensor, the engines stops automatically. Two kinds of filters are used for several investigations. The glassfibre-filter is for analysing the organics in the dust, while the cellulose-filters will be used for grain-size measurements, chemical and mineralogical analysis. Seven samples were taken on the second leg (Table 1).

Table 1. Samples collected for dust investigations.

Collection time 2008	**Sample identification**
19-20/04	GlassFib01, CellFib01
21-22/04	GlassFib02, CellFib02
22-23/04	GlassFib03, CellFib03
23-24/04	GlassFib04, CellFib04
25-26/04	GlassFib05, CellFib05
26-27/04	GlassFib06, CellFib06
27-28/04	GlassFib07, CellFib07

2.2. Biogeochemistry and Oceanography (Leg 1)

2.2.1. Surveys at ESTOC and off Cape Blanc *(M. Villagarcía, D.V. Moreno)*

Objectives and scientific questions

Along P365a the ANIMATE/ ESTOC mooring was recovered for the last time. It had been put in place in November 2007 during P360 and the sensors had been in the water for about 5 months.

At the same time, it was necessary to do the biogeochemical monthly samplings at the ESTOC station (**E**uropean **S**tation for **T**ime series in the **O**cean **C**anary islands), as it has been continuously done since 1994. A calibration cast before the final recovery of the mooring with CTD/Rosette were also made to accomplish the requirements of the sensors being recovered.

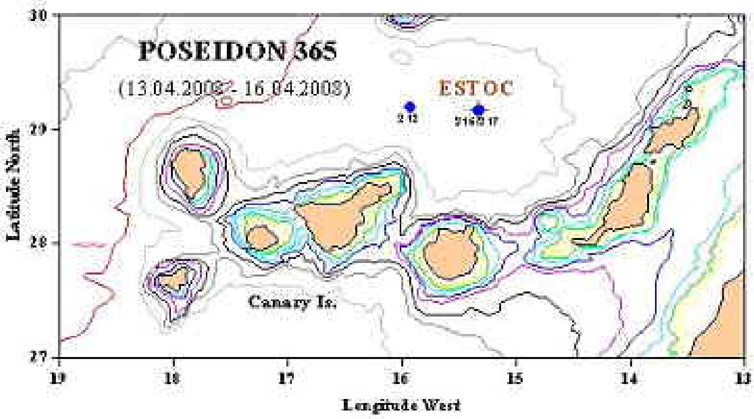


Fig. 2. Position of the CTD stations (blue circles) made along Poseidon P365 (Leg 1).

At the beginning of the cruise, the DOLAN/ANIMATE mooring had to be recovered, hence a rosette/CTD cast to 1000m was made in order to have a calibration of the chemical sensors before their recovery (station #212_2, 13th April 2008). The same cast was used to collect water for the sediment trap mooring that was going to be replaced.

Then, after the DOLAN mooring with the chemical sensors from ANIMATE was recovered, the ESTOC station monthly sampling took place by means of two profiles done on 14th and 15th of April 2008 (station 215_01, sampled to the bottom and 217_01 sampled to 800m) (see station list).

The nutrient sensor NAS-3X© number 2625 was recovered with data of 5 months, the preliminary analysis shows in general good data with some gaps where the data was unacceptable. One of the standards did not provide adequate response, only the standard with a concentration 2 of nitrate was used to calculate the nitrate and nitrite data.

Table 2. List of stations sampled along the cruise P365 (Leg 1), Las Palmas- DOLAN- Las Palmas (O=oxygen, CO_2 = Carbon dioxide, N=nutrients, S=salinity, C=chlorophyll "a", HPLC = pigments, Inc= Incidences) .

Date Time (hh:mm	St. #, CTD, Cast	Depth sta,m	Lat. N	Long. W	Depth Ro,db	Nisk bot.	Depth samp, db	PARAMETERS O	CO_2	N	S	C	HPLC	Inc
13.04. 2008 18:54	212, 02	3634	29º11.53'	15º56.05'	1000			Station to collect water fro traps and for pre-recovery calibration of mooring sensors						
						1	1000	Sediment traps water						
						2	1000	Sediment traps water						
						3	200	√		√	√	√	√	
						4	150	√		√		√	√	
						5	100	√		√		√	√	
						6	90	√		√		√	√	
						7	80	√		√		√	√	
						8	70	√		√		√	√	
						9	55	√		√		√	√	
						10	40	√		√		√	√	
						11	25	√		√	√	√	√	
						12	10	√		√		√	√	
14.04. 2008 16:15	215, 01	3643	29º10.00'	15º20.00'	3500			ESTOC April 2008, Deep profile						
						1	3500	√	√	√	√			
						2	3000	√	√	√	√			
						3	2800	√	√	√	√			
						4	2500	√	√	√	√			
						5	2000	√	√	√	√			
						6	1800	√	√	√	√			
						7	1500	√	√	√	√			
						8	1300	√	√	√	√			
						9	1200	√	√	√	√			
						10	1100	√	√	√	√			
						11	1000	√	√	√	√			
						12	800	√	√	√	√			
15.04. 2008 11:40	217, 01	3595	29º10.02'	15º20.05'	800			ESTOC April 2008, Shallow profile						
						1	800	√	√	√	√			
						2	600	√	√	√	√			
						3	400	√	√	√	√			
						4	300	√	√	√	√			
						5	200	√	√	√	√	√	√	
						6	150	√	√	√	√	√	√	
						7	125	√	√	√	√	√	√	
						8	100	√	√	√	√	√	√	
						9	75	√	√	√	√	√	√	
						10	50	√	√	√	√	√	√	
						11	25	√	√	√	√	√	√	
						12	10	√	√	√	√	√	√	

Physical (CTD, salinity) and biochemical (oxygen, CO_2, nutrients, chlorophyll and pigments) parameters were measured in order to characterize the water masses present in the water column (Table 2). Some of the parameters (oxygen, chlorophyll and pigments filtration) were analysed on board after sampling, and others were taken frozen to the ICCM (nutrients and filters from chlorophyll).

Methods

Water Sampling

Samples were collected immediately after the Niskin bottles were on board from each depth. The sampling sequence was as follows:

1.) Oxygen: was taken in glass bottles of about 125 ml of volume which were previously cleaned and washed with HCl acid and was fixed at once; then it was kept for at least six hours according to WOCE regulations and finally it was analysed at the laboratory on board the ship.

2.) Carbon system measurements: only taken at ESTOC, and in this case pH and alkalinity: samples were taken in glass bottles and were fixed immediately on board.

3.) Nutrients: were taken in polypropylene bottles which were previously cleaned and washed with HCl acid and were completely dry. Samples were immediately frozen at -20°C, analysing them as soon as possible after arrival at the laboratory. Freezing the samples is a common practice; it does not or only in a non-significant way affect the nitrate and nitrite and the phosphate values (by a slight decrease) and is not noticeable in the silicate values (Kremling and Wenck,1986; McDonald and McLunghlin, 1982).

4.) Salinity: samples were taken in dark glass bottles which were previously cleaned and washed with HCl acid. Then, they were kept in boxes to protect them from light till analysis on land.

5.) Chlorophyll: samples of one liter of water were taken. The chlorophyll samples were filtered immediately and the filters were frozen subsequently at -20°C. Their analyses takes place at the ICCM home laboratory.

6.) Pigments: samples of one liter of water were taken and filtered immediately after sampling took place and the filters were deep frozen in liquid nitrogen to be maintained at –80ºC. Their analyses takes place at the ICCM home laboratory.

All samples were taken using the procedures established in the WOCE Operations Manual, WHP Office Report WHPO 91-1/WOCE Report No.68/91.

Analysis

Dissolved Oxygen :The samples were analysed using the method described in the WOCE Operations Manual, WHP Office Report No. 68/91; the final titration point was detected using a Metrohm 665 Dosimat Oxygen Auto-Titrator Analyser.

Carbonate system measurements

The pH_t in total scale (mol (kg-SW)$^{-1}$) was measured following the spectrophotometric technique of Clayton and Byrne (1993) using the m-cresol purple indicator (DOE, 1994). 0.0047 pH units were added to the pH experimental values in order to take into consideration the recommendations by Lee et al. (2000). A system similar to that described by Bellerby et al. (1995) was developed in our lab. The pH_t measurements were carried out using a Hewlett Packard Diode Array spectrophotometer in a 25ºC-thermostated 1-cm flow-cell using a Peltier system. A stopped-flow protocol was used to analyse seawater previously thermostated to 25ºC for a blank determination at 730, 578 and 434 nm. The flow was restarted, and the indicator injection valve switched on to inject 10 µl dye through a mixing coil (2 m). Three photometric measurements were carried out for each injection in order to remove all dye effect on the seawater pH_t measurement. Repeatedly, seawater measurements of the different Certified Reference Materials (CRM provided by Dr. Dickson, Scripps Institution of Oceanography) samples gave a standard deviation of ± 0.0015 (n = 54).

The total alkalinity of seawater (A_T) was determined by titration with HCl to the carbonic acid end point using two similar potentiometric systems, as described in more detail by Mintrop et al. (2000). In order to yield an ionic strength similar to open ocean seawater, the HCl solution (25 l, 0.25 M) was made from concentrated analytical grade HCl (Merck®, Darmstadt, Germany) in 0.45 M NaCl. The acid was standardised by titrating weighed amounts of Na_2CO_3 dissolved in 0.7 M NaCl solutions. The total alkalinity of seawater was evaluated from the proton balance at the alkalinity equivalence point, pH_{equiv} = 4.5, according to the exact definition of total alkalinity (Dickson, 1981). The performance of the titration systems was monitored by titrating different samples of certified reference material (CRM, batch 42) with known inorganic carbon and A_T values. The agreement between our data and CRM values was within ±1.5 µmol kg^{-1}. Total inorganic carbon (C_T) is computed from experimental values of pH_t and total alkalinity, using the carbonic acid dissociation constants of Mehrbach after Dickson and Millero (1987). This set of constants presented the best agreement between C_T(pH, A_T) calculations and certified C_T values for CRM, batch 42, with a C_T residual of ± 3 µmol kg^{-1}, n=54 (Millero, 1995, Lee et al., 1997).

Nutrients

The nutrients determination was performed with a segmented continuous-flow autoanalyser, a Skalar® San Plus System (ICCM).

Nitrate and Nitrite: The automated procedure for the determination of nitrate and nitrite is based on the cadmium reduction method; the sample is passed through a column containing granulated copper-cadmium to reduce the nitrate to nitrite (Wood et al.,1967), using ammonium chloride as pH controller and complexer of the cadmium cations formed (Strickland and Parsons, 1972). The optimal column preparation conditions are described by several authors (Nydahl, 1976; Garside, 1993).

Phosphate: Orthophosphate concentration is understood as the concentration of reactive phosphate (Riley and Skirpow,1975) and according to Koroleff (1983a) is a synonym of "dissolved inorganic phosphate". The automated procedure for the determination of phosphate is based on the following reaction: ammonium molybdate and potassium antimony tartrate react in an acidic medium with diluted solution of phosphate to form an antimony-phospho-molybdate complex. This complex is reduced to an intensely blue-coloured complex, ascorbic acid. The complex is measured at 880nm. The basic methodology for this anion determination is given by Murphy and Riley (1962); the used methodology is the one adapted by Strickland and Parsons (1972).

Silicate: The determination of the soluble silicon compounds in natural waters is based on the formation of the yellow coloured silicomolybdic acid; the sample is acidified and mixed with an ammonium molybdate solution forming molybdosilicic acid. This acid is reduced with ascorbic acid to a blue dye, which is measured at 810nm. Oxalic acid is added to avoid phosphate interference. The used method is described in Koroleff (1983b).

Phytoplankton pigments: Pigments were measured using fluorimetric analysis, following the methodology described by Welschmeyer (1994). The determination was achieved using a fluorometer TURNER 10-AU-000.

Salinity: Samples were measured with a salinometer, model Autosal 8400a, whose measurement range was between 0.005-42 (psu), with an accuracy of ±0.003, according to the manufacturer. It was calibrated following the manufacturer´s information and standarizing it with IAPSO Standard Seawater. Salinity values were calculated as practical salinity according to Unesco (1978, 1984).

Pigments: Samples are defrozen in an ultrasound bath and extraction is done with methanol before being analysed by HPLC (High Performance Liquid Cromatography). The extraction process used was described by Wright et al.(1991); this procedure was proposed as the JGOFS (Joint Global Ocean Flux Study) standard methodology for phytoplankton pigment determination (1994). Some modifications for improving the method were done by Wright in 2006.

Preliminary Results

This cruise took place during spring, which corresponds in surface waters and for this area, to the time of the year when the mixed layer of about 125-150 m that was formed during the late winter disappears, and it starts the seasonal thermocline formation which is shown by the slope profile found (Figure 3). If we look at the results of the preceeding year, the 2007 sampling in the spring took place along P320 in March, and hence temperature values were lower and the mixed layer was more homogeneous (Figure 4).

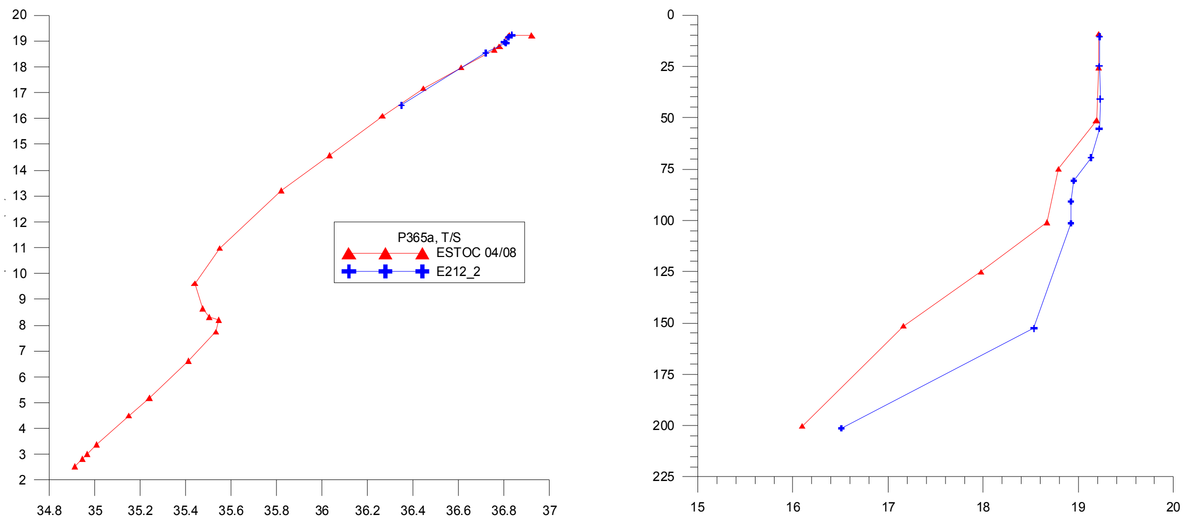


Fig. 3. T/S diagram for the stations sampled (left) and potential temperature versus pressure showing the breakage of the mixed layer (right).

The only station sampled for deeper waters was ESTOC and there the subsurface waters encountered below the mixed layer represent the temperature and salinity values that characterise the NACW (North Atlantic Central Water) straight line. The range of values were 12- 17.5ºC and 35.6- 36.6 for temperature and salinity, respectively. (Figure 3). At intermediate waters level, no presence of Mediterranean Water (MW) was found at ESTOC during the cruise (about 7-11ºC of temperature), since all salinity values encountered were below 35.5 units, which is the limit of the Mediterranean Water (see example in Llinás et al., 2003). However, at these depths, the Antarctic Intermediate Water (AAIW) was found and from Figure 3 it seems there was a mixing of both types of water masses, giving a salinity maximum of about 35.5 in that water depth.

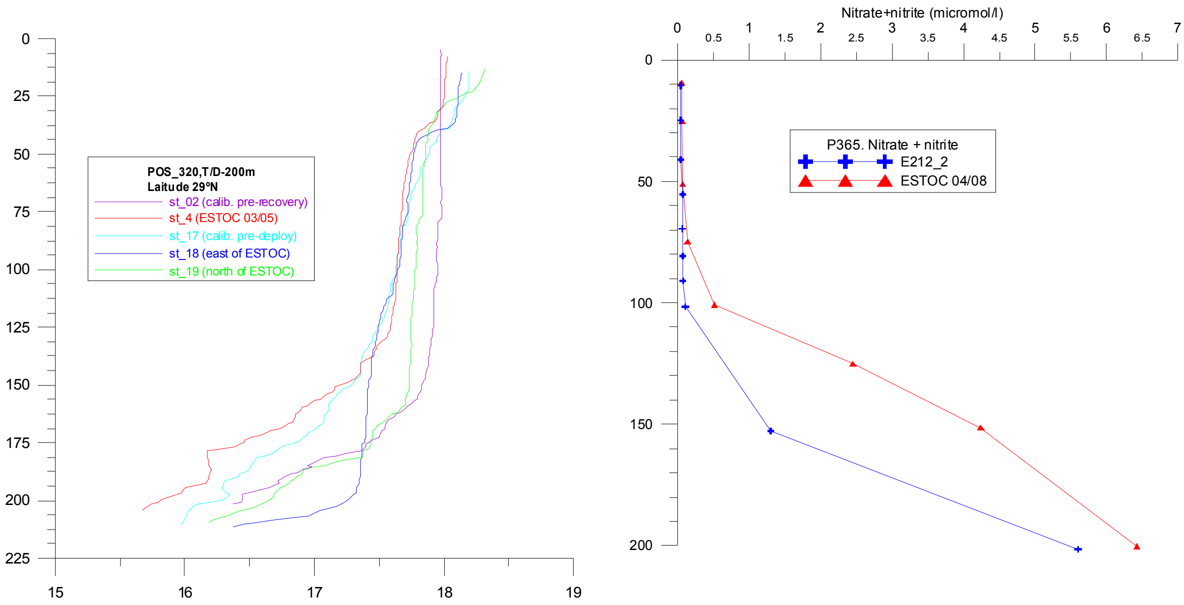


Fig. 4. Mixed layer of stations including ESTOC (in red) from cruise P320 sampling at ESTOC in March 2007 (left). Nitrate and nitrate values from the stations made along P365 (Leg 1) (right).

Nutrients for the upper 200m are shown in Figures 4 and 5. The nitracline is detected at 100m just below the chlorophyll “a” maximum (Figure 6), above these depths there is depletion of nitrates and nitrites and phosphates due to the photosynthetic activity of the surface waters.

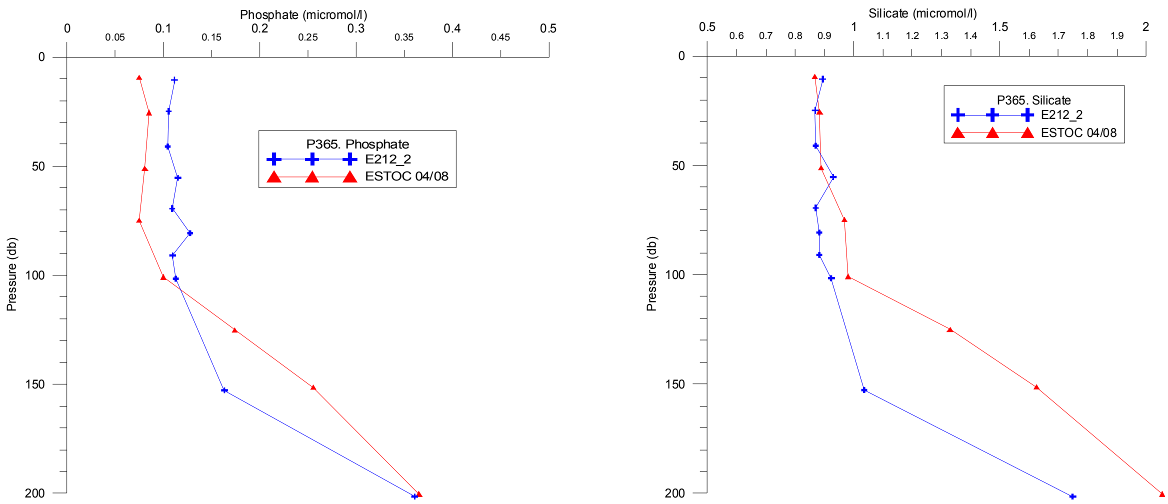


Fig. 5. Phosphate values taken at both stations made along P365 (Leg 1) for the upper 200m (left) and silicate values from the same stations (right).

The silicate values are slightly higher than the other two nutrients, a feature characteristic for this area. Below 100m there is a strong increase of nutrients values, detecting around 6.5 µmols/l of nitrate and nitrite, 0.35 µmols/l of phosphates and 2 µmols/l of silicates at 200m. These nutrients values have been compared with the 10-year nutrients time series that ICCM has been taking from ESTOC, and the data measured are within the expected range for the spring in this area.

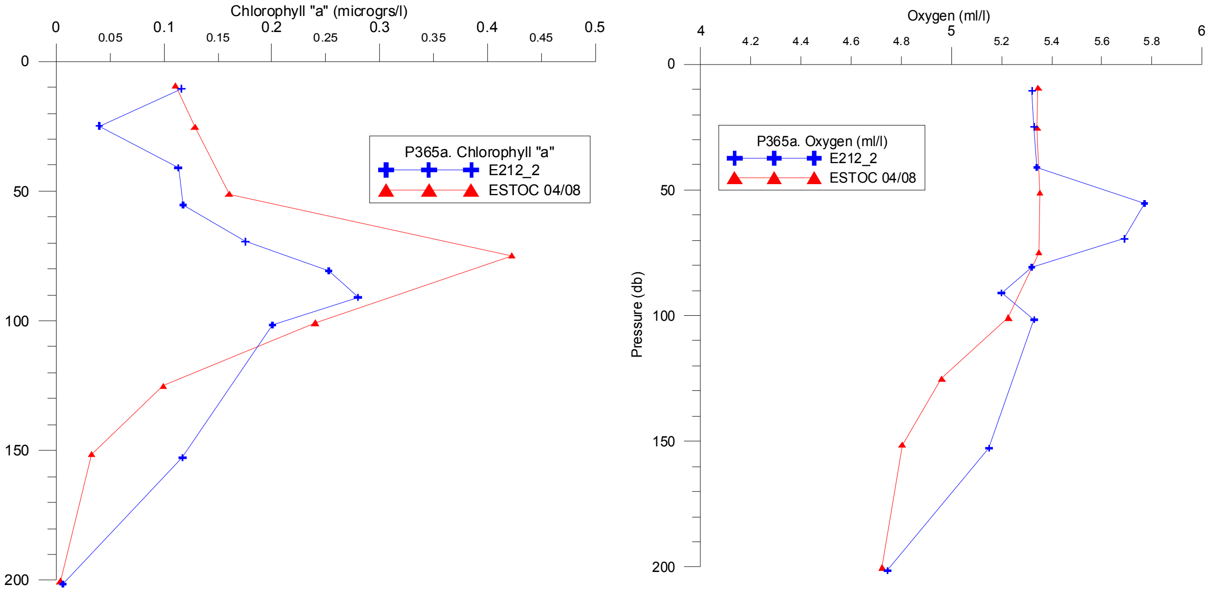


Fig. 6. Chlorophyll “a” sampled at both stations made along P365 (Leg 1) for the upper 200m (left) and oxygen values for the same stations (right).

The chlorophyll „a“ is plotted in Figure 6 for ESTOC and the calibration station. Values ranged between 0 and 0.45 µg/l at latitude 29ºN, showing a maxima at 70m of depth for ESTOC and about 90 m for station 212_2. The variability found for the maxima at each station is related to thermocline formation effects already mentioned. The mixed layer was loosing its homogeneity along the cruise days, and if there were inputs of nutrients from below, the amount of phytoplankton increases producing greater fluorescence values at different depths. An increase in phytoplankton standing stock is also shown in the increase of the oxygen maximum at about 50 m in one of the stations (Figure 6).

The cruise P365 Leg 2 had the following aims for ICCM:

- Seven expandable bathythermograph (XBT, T5, 1830 m) were launched to characterize the water column between the south of the islands and the most westerly station of Cape Blanc (Table 3).
- To carry out hydrographic investigations in the Cape Blanc area, 6 stations were made at this latitude, some to 2000 m and other down to 800 m. Samples for oxygen, nutrients, salinity and chlorophyll “*a*” were taken. Oxygen values were determined on board (Table 4).
- In Cape Blanc stations were the CTD was only done until 800 m, a XBT was launched (in stations: GeoB 12908(St2a), GeoB 12911(St4) and GeoB 12914 (St5) (Table 3).

Table 3. List of XBT's launched.

File name	Date (dd/mm/yy)	Latitude N	Longitude W
P365B_XBT_1	18/04/08	27º 00.000	16º 03.110
P365B_XBT_2	19/04/08	26º 02.574	16º 51.389
P365B_XBT_3	19/04/08	25º 05.148	17º 39.271
P365B_XBT_4	19/04/08	24º 07.722	18º 26.776
P365B_XBT_5	19/04/08	23º 10.296	19º 13.923
P365B_XBT_6	20/04/08	22º 12.870	20º 00.730
P365B_XBT_7	20/04/08	21º 16.797	20º 47.480
P365B_XBT_St2a	21/04/08	20º 59.485	19º 40.853
P365B_XBT_St4	23/04/08	20º 04.848	18º 58.960
P365B_XBT_St5	25/04/08	21º 18.462	18º 49.649

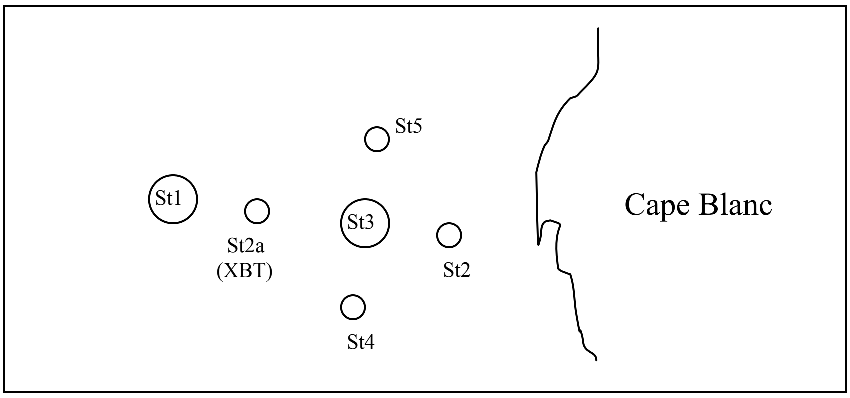


Fig. 7. Location of stations done by the ICCM and their positions off Cape Blanc, Mauritania.

Table 4. List of stations sampled by ICCM along 365 (Leg 2). DP= Deep Profile, SP= Shallow Profile, Chloroph= chlorophyll "a", Inc= Incidences/ Comments. NW= not enough water available for some parameter.

Station Name: GeoB12907-2 (St1) **Date: 20/04/08** **Time: 20:03**

SP:E227 **Latitude: 21º 16.908 N** **Longitude: 20º 48.136 W**

Niskin	Depth	Oxygen	Nutrients	Salinity	Chloroph.	Inc.
1	800	√	√			
2	600	√	√	√		
3	400	√	√			
4	300	√	√			
5	200	√	√		√	
6	150	√	√		√	
7	125	√	√		√	
8	100	√	√		√	
9	75	√	√		√	
10	50	√	√		√	
11	25	√	√	√	√	
12	10	√	√		√	

Table 4. continued

Station Name: GeoB12907-4 (St1) **Date: 21/04/08** **Time: 06:11**
DP: E228 **Latitude: 21º 16.908 N** **Longitude: 20º 48.136 W**

Niskin	Depth	Oxygen	Nutrients	Salinity	Chloroph.	Inc.
1	2000					
2	2000	√	√	√		
3	1800	√	√			
4	1600	√	√			
5	1400	√	√			
6	1200	√	√			
7	1000	√	√			
8	800	√	√	√		
9	500					
10	500	√	√			
11	35					
12	35	√	√		√	

Station Name: GeoB12909-1(St 2) **Date: 22/04/08** **Time: 17:46**
SP: E231 **Latitude: 21º 16.908 N** **Longitude: 20º 48.136 W**

Niskin	Depth	Oxygen	Nutrients	Salinity	Chloroph.	Inc.
1	700					
2	700	√	√	√		
3	600	√	√			
4	400					
5	400	√	√			
6	300	√	√			
7	200	√	√		√	
8	100	√	√		√	
9	50	√	√		√	
10	35					
11	35	√	√	√	√	
12	10	√	√		√	

Station Name: GeoB12911-2 (St4) **Date: 23/04/08** **Time: 19:00**
SP: E234 **Latitude: 20º 04.694 N** **Longitude: 18º 58.725 W**

Niskin	Depth	Oxygen	Nutrients	Salinity	Chloroph.	Inc.
1	800	√	√			
2	600	√	√	√		
3	400	√	√			
4	300	√	√			
5	200	√	√		√	
6	150	√	√		√	
7	125	√	√		√	
8	100	√	√		√	
9	75	√	√		√	
10	50	√	√		√	
11	25	√	√	√	√	
12	10	√	√		√	

Station Name: GeoB12912-1 (St3) **Date: 24/04/08** **Time: 8:00**
SP: 235 **Latitude: 20º 44.999 N** **Longitude: 18º 41.964 W**

Niskin	Depth	Oxygen	Nutrients	Salinity	Chloroph.	Inc.
1	800	√	√			
2	600	√	√	√		
3	400	√	√			
4	300	√	√			
5	200	√	√		√	
6	150	√	√		√	
7	125	√	√		√	
8	100	√	√		√	
9	75	√	√		√	
10	50	√	√		√	
11	25	√	√	√	√	
12	10	√	√		√	

Table 4. continued

Station Name: GeoB12912-2 (St3) **Date: 24/04/08** **Time: 9:30**
DP: 235 **Latitude: 20º 44.973 N** **Longitude: 18º 41.991 W**

Niskin	Depth	Oxygen	Nutrients	Salinity	Chloroph.	Inc.
1	2500					
2	2500	√	√	√		
3	2200	√	√			
4	2000	√	√			
5	1800					
6	1800	√	√			
7	1500	√	√			
8	1300	√	√			
9	1000	√	√			
10	800	√	√	√		
11	75					
12	75					

Station Name: GeoB12914-3 (St5) **Date: 25/04/08** **Time: 18:46**
SP: 238 **Latitude: 21º 19.83 N** **Longitude: 18º 49.58 W**

Niskin	Depth	Oxygen	Nutrients	Salinity	Chloroph.	Inc.
1	800	√	√			
2	600	√	√	√		
3	400	√	√			
4	300	√	√			
5	200	√	√		√	
6	150	√	√		√	
7	100	√	√		√	
8	75	√	√		√	
9	50	√	√		√	
10	25	√	√	√	√	
11	10	√	√		√	
12	Neptuno Gift					

Water Sampling

Samples were collected immediately after Niskin bottles were on board from each depth. The sampling sequence was as follows:

- Oxygen*:* was taken in glass bottles of about 125 ml of volume which were previously cleaned and washed with HCl acid and with the seawater which is going to be taken. Oxygen was fixed at once; then it was kept for at least six hours before the determination according to WOCE regulations and finally it was analysed at the laboratory on board the ship.
- Nutrients*:* were taken in polypropylene bottles which were previously cleaned and washed with HCl acid and were completely dry. In the moment of taking samples, bottles were cleaned with the seawater which is going to be taken. Samples were immediately frozen at least at -20ºC, analysing them as soon as possible after arrival at the laboratory on land at the ICCM.
- Salinity*:* samples were taken in dark glass bottles which were previously cleaned and washed with HCl acid and before taking samples with that seawater. Then, they were kept in boxes to protect them from light till analysis on land at the ICCM.

- Chlorophyll<u>a</u>: samples of one litre of water were taken. The chlorophyll samples were filtered immediately (500 ml, the rest of water is for cleaning the system) and the filters were frozen subsequently at least at -20ºC. Their analysis will be done at the ICCM.

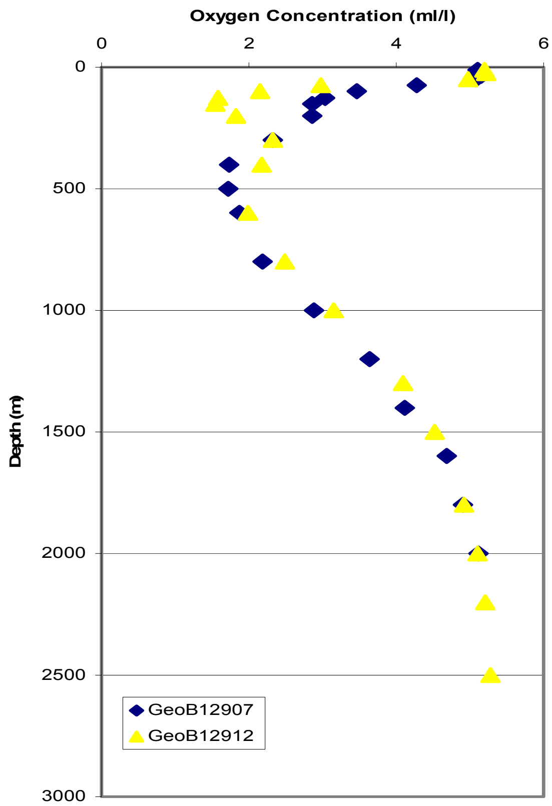
<u>Analysis</u>

- Dissolved Oxygen*:* samples were analysed using the method described in the WOCE Operations Manual, WHP Office Report No. 68/91; the final titration point was detected using a Metrohm 665 Dosimat Oxygen Auto-Titrator Analyser.
- Nutrients*:* nutrient determination will be performed with a segmented continuous-flow autoanalyser, a Skalar® San Plus System.
- Phytoplankton Pigments*:* pigments will be measured using fluorometric analysis, following the methodology described by Welschemeyer (1994). The determination will be achieved using a fluorometer TURNER 10-AU-000.
- Salinity*:* samples will be measured with a salinometer, model Autosal 8400a, whose measurement range was between 0.005-42 (psu), with an accuracy of ±0.003, according to the manufacturer.

Preliminary Results

On board only the XBT's results and oxygen measurements were obtained and the results are only preliminary (Fig. 8). Initial visual correction for errors was made; further checking will be done once the results of the parameters analysed on land are obtained.

Oxygen Results



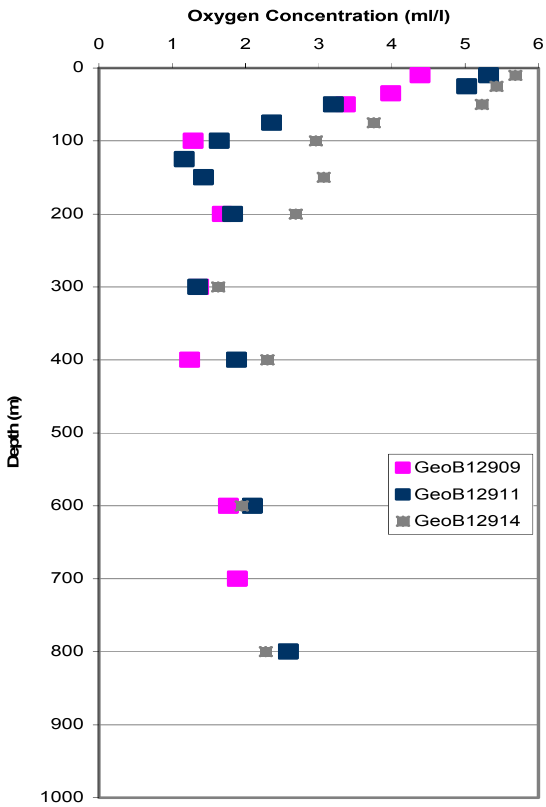


Fig. 8. Oxygen profiles done on POS 365 (Leg 2): profiles down to 2500 m (left) and down to 800 m water depth (right).

XBT's Results

Values for the seven XBT launched during the transect Las Palmas-Cape Blanc are showed in Figure 9. Deep values show the general temperature values found for this subtropical area (4º-8ºC). Antartic Intermediate Water is sometimes detected around 600-800 m. Cooler subsurface waters are found to the south and east, probably due to the influence of the upwelled water encountered in the Cape Blanc area.

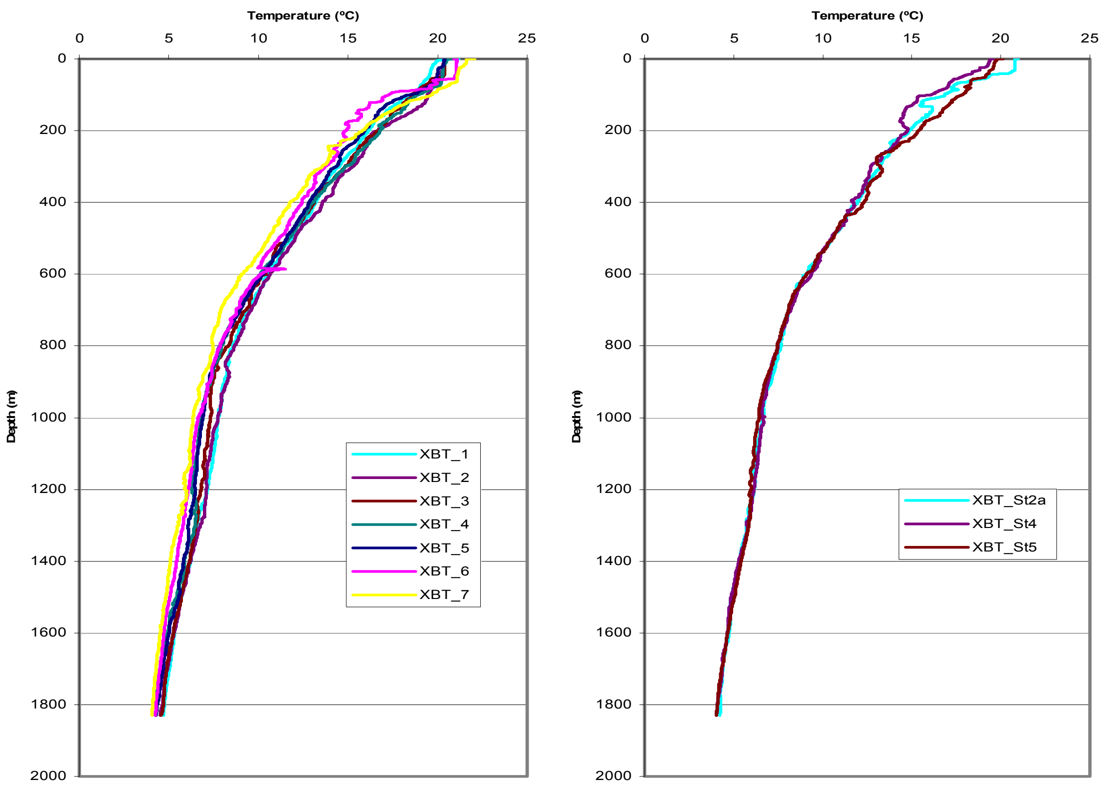


Fig. 9. Temperature versus depth for the seven XBT's of the transect (left) and for the three XBT stations off Cape Blanc (right).

2.2.2. Testing the new optical nitrate sensor (NICO project) (*E. Kopiske)*

This cruise covers the ROV test of the PROPS sensor with the ROV *Cherokee*. The "NICO" Project (Nitrate Continuous Observation Sensor) shall continue the development of the PROPS sensor in order to have an optical nitrate sensor for long term use in moorings in the marine science. The part of the MARUM is the practical use of the sensor on seagoing expeditions in several applications. The sensor was used in the laboratory with a flow-through-cuvette for the analysis of the samples from the rosette. The sensor was also mounted on the MARUM ROV *Cherokee* in order to get online photometric spectra during a ROV dive. The online-spectra can not only be used for nitrate measurement but also for a quantitative measurement of other substances like yellow substance (Gelbstoff).

Offline measurements in the lab

92 water samples were collected during the cruise at 8 CTD stations (Table 5). Two bottles were taken from every sample, one was measured on board and the other was frozen at -40°C for a later reference analysis at the IFM-GEOMAR in Kiel. The bottles were rinsed with distilled water before the cruise and three times with the sample water before filling them with the sample. The second bottle was analyzed in the laboratory with the PROPS sensor by the use of a flow-through-cuvette. The cuvette was rinsed with approx. 50 ml of the sample before the analysis. Three measurements were taken with renewed water in the cuvette. The temperature was measured with a “Testo 826-T4” infrared temperature probe in order to have an uncontaminated sample.

In situ measurements with the ROV Cherokee

The PROPS sensor has never been used in an online and profiling configuration until now. The big advantage is that the spectra can be viewed online and that a substance analysis for nitrate or other substances can be viewed in parallel. The sensor was mounted on the ROV on the port forward corner of the ROV. The optical path length was 20 mm for this test. The connection was possible with a adapter bottle which converts the sensor interface to Schilling Seanet Hub standard. The connection to the ROV was made with a standard Schilling Seanet cable. The ROV provided the 24V power supply and an RS232 interface for the PROPS sensor. A Laptop with an USB to RS232 adapter was used for the GUI. The operator was sitting beside the ROV pilot in the ROV control lab. The standard msda_xe software was used to operate the sensor and to view the online data. The configuration of the sensor was to take measurements automatically every minute. The recorded spectra have been displayed as an overlay of 99 spectra. This allows the operator to analyze the change in the signal while descending. The recorded spectra show the increase of nitrate with depth and also a signal which was interpreted as yellow substance (Gelbstoff). This was the first time we had an online sensor for chemical parameters on the ROV. Only one ROV station was done due to high swell.

Table 5. List of samples taken for the NICO project.

Internal label	Ship_station #	GEOB #	Water depth
#1-215_01-3500	215-1	12903-1	3500
#2-215_01-3000	215-1	12903-1	3000
#3-215_01-2800	215-1	12903-1	2800
#4-215_01-2500	215-1	12903-1	2500
#5-215_01-2000	215-1	12903-1	2000

Table 5 continued

#6-215_01-1800	215-1	12903-1	1800
#7-215_01-1500	215-1	12903-1	1500
#8-215_01-1300	215-1	12903-1	1300
#9-215_01-1200	215-1	12903-1	1200
#10-215_01-1100	215-1	12903-1	1100
#11-215_01-1000	215-1	12903-1	1000
#12-215_01-800	215-1	12903-1	800
#1-217_01-800	217-1	12905-1	800
#2-217_01-600	217-1	12905-1	600
#3-217_01-400	217-1	12905-1	400
#4-217_01-300	217-1	12905-1	300
#5-217_01-200	217-1	12905-1	200
#6-217_01-150	217-1	12905-1	150
#7-217_01-125	217-1	12905-1	125
#8-217_01-100	217-1	12905-1	100
#9-217_01-75	217-1	12905-1	75
#10-217_01-50	217-1	12905-1	50
#11-217_01-25	217-1	12905-1	25
#12-217_01-10	217-1	12905-1	10
#1-3	227-1	12907-2	800
#2-3	227-1	12907-2	600
#3-3	227-1	12907-2	400
#4-3	227-1	12907-2	300
#5-3	227-1	12907-2	200
#6-3	227-1	12907-2	150
#7-3	227-1	12907-2	125
#8-3	227-1	12907-2	100
#9-3	227-1	12907-2	75
#10-3	227-1	12907-2	50
#11-3	227-1	12907-2	25
#12-3	227-1	12907-2	10
#1-4	232-1	12909-1	700
#2-4	232-1	12909-1	700
#3-4	232-1	12909-1	600
#4-4	232-1	12909-1	400
#5-4	232-1	12909-1	400
#6-4	232-1	12909-1	300
#7-4	232-1	12909-1	200
#8-4	232-1	12909-1	100
#9-4	232-1	12909-1	50
#10-4	232-1	12909-1	35
#11-4	232-1	12909-1	35
#12-4	232-1	12909-1	10
#1-5	234-2	12911-2	800
#2-5	234-2	12911-2	600
#3-5	234-2	12911-2	400
#4-5	234-2	12911-2	300
#5-5	234-2	12911-2	200
#6-5	234-2	12911-2	150
#7-5	234-2	12911-2	125

Table5 continued

#8-5	234-2	12911-2	100
#9-5	234-2	12911-2	75
#10-5	234-2	12911-2	50
#11-5	234-2	12911-2	25
#12-5	234-2	12911-2	10
#1-6	235-1	12912-1	800
#2-6	235-1	12912-1	600
#3-6	235-1	12912-1	400
#4-6	235-1	12912-1	300
#5-6	235-1	12912-1	200
#6-6	235-1	12912-1	150
#7-6	235-1	12912-1	125
#8-6	235-1	12912-1	100
#9-6	235-1	12912-1	75
#10-6	235-1	12912-1	50
#11-6	235-1	12912-1	25
#12-6	235-1	12912-1	10
#1-7	235-2	12912-2	2500
#2-7	235-2	12912-2	2500
#3-7	235-2	12912-2	2200
#4-7	235-2	12912-2	2000
#5-7	235-2	12912-2	1800
#6-7	235-2	12912-2	1800
#7-7	235-2	12912-2	1500
#8-7	235-2	12912-2	1300
#9-7	235-2	12912-2	1000
#10-7	235-2	12912-2	800
#11-7	235-2	12912-2	75
#12-7	235-2	12912-2	75
#1-8	238-2	12914-3	800
#2-8	238-2	12914-3	600
#3-8	238-2	12914-3	400
#4-8	238-2	12914-3	300
#5-8	238-2	12914-3	200
#6-8	238-2	12914-3	150
#7-8	238-2	12914-3	100
#8-8	238-2	12914-3	75
#9-8	238-2	12914-3	50
#10-8	238-2	12914-3	25
#11-8	238-2	12914-3	10

Preliminary results of the measurement on board

The PROPS sensor was working well during the whole cruise. The sensor performed very well also on the ROV. The recorded spectra were very stable and with a low noise. We could see a yellow-substance signal in some depth. Figure 10 shows the spectra recorded at 50 m, 100 m, 250 m and 400 m. The absorption at 220 nm increases with the depth, the lowest absorption is at 50 m.

The algorithm for the determination of the nitrate concentration did not work very well on board. One problem could be that the distilled water reference spectra was not at zero value after a series of measurements. Thus, we sometimes obtained negative nitrate concentrations. This problem has to be analyzed with the instruments manufacturer TriOS GmbH.

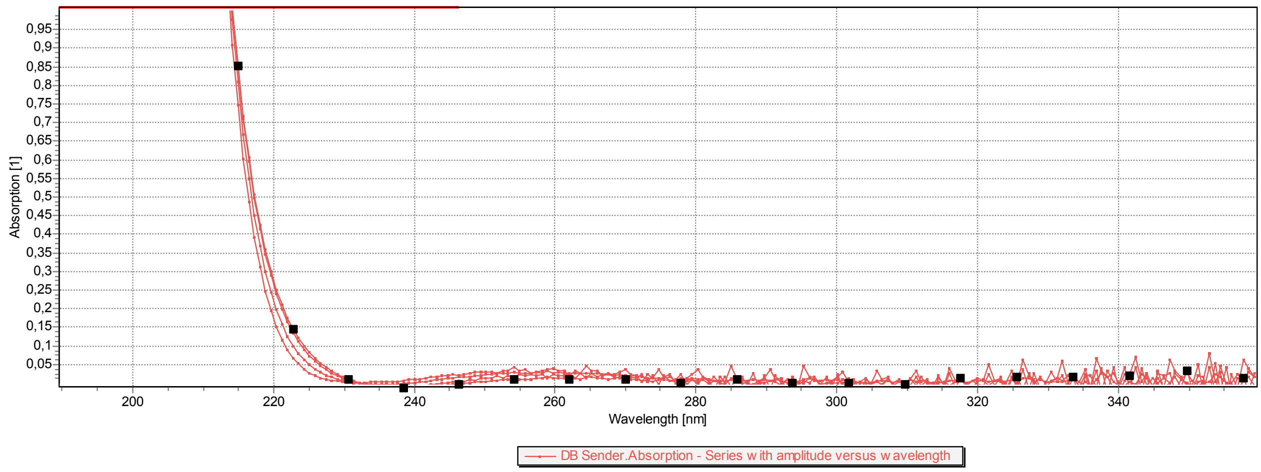


Fig. 10. Absorption amplitude vs. wavelength of a series of sample measurements with the PROPS sensor.

2.2. Marine Microbiology

2.2.1 Particle composition and size-related settling velocity *(Morten Iversen)*

At earlier cruises (POS-344 and MSM04b), we observed a sub-surface peak in the particle abundance. Such a peak has previously been described as an up-concentration of particles at density discontinuities. This is due to decreased settling velocity of the aggregates when they enter water masses with increasing density (McIntyre et al., 1995). However, when we compared the particle peak with the density discontinuities we did not find a strong correlation. The particle peak could form because particles with low density are laterally advected from the coastal water and into the open water (Nowald et al., 2006). To enable a better understanding of these observations, we made roller tank incubations to form aggregates. The incubations were done with water from the fluorescence maximum, from the sub-surface particle peak, and from the deep water below the particle peak. Roller tank incubation imitates the formation of marine snow aggregates, as it happens *in situ* via differential settling. Once the aggregates were formed, we measured size and settling velocity of individual aggregates. If the particle peak was due to lateral advection of particles from the coast, we expected to observe heterogeneity among the particles formed from water collected in the peak.

We only observed a clear sub-surface peak at station GeoB 12912. We formed aggregates from the water above, in, and below the peak and measured the settling velocity and size of the aggregates from the different depths (Fig. 11).

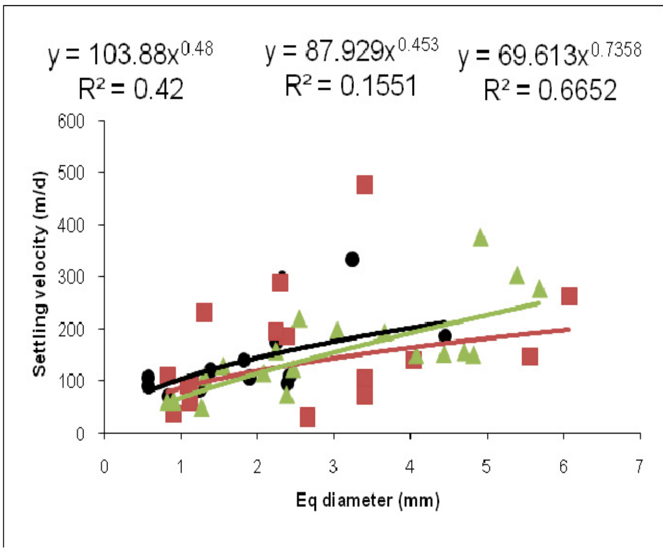


Fig. 11. Settling velocity versus size (equivalent spherical diameter) of the aggregates formed from water collected at GeoB 12912-1. Black circles are aggregates formed in water collected at 75 m (fluorescence maximum above the peak), red squares are aggregates formed in water from 1800 m (particle peak), and green triangles are aggregates formed in water collected at 2500 m depth (below the peak). The equations for the regression are also shown; from left to right for 75 m, 1800 m, and 2500 m.

We found a high heterogeneity in the settling velocity for the aggregates formed from the water collected within the particle peak (Fig. 11). This indicates that there is a different composition of material at this depth compared to the water above and below. Hence, our preliminary results point towards a lateral advection of particles which form the sub-surface particle peak observed off Cape Blanc. Though we did not observe a particle peak at all stations, we still made roller tank incubations and measurements of the aggregates formed at different depth (Table 6).

Table. 6. List of water samples taken for microbiological investigations.

Station GeoB #	**Sample depth (m)**	**Sample volume (L)**	**Analysis**
12907-4	35	20	POC content in water
	500	20	Aggregate formation
	2000	20	Aggregate size and settling velocity
12909-1	35	20	POC content in water
	400	20	Aggregate formation
	700	20	Aggregate size and settling velocity
12912-2	75	20	POC content in water
	1800	20	Aggregate formation
	2500	20	Aggregate size and settling velocity
12914 (pump)	3	50	POC content in water
			Aggregate formation
			Aggregate size and settling velocity

2.4. Oceanography and Marine Geology

2.4.1 CTD-O_2-chlorophyll-fluorescence probes (SBE-19 and SBE-3)

(N. Nowald, C. Reuter, M. Klann, G. Fischer)

Five CTD/O_2/chlorophyll-fluorescence profiles were taken with a self-contained SBE 19 profiler equipped with a conductivity-temperature-depth probe plus oxygen sensor and a CHELSEA-fluorometer. This CTD was attached to the frame of the ParCa system and was deployed five times during the cruise (see Table 7). The data were removed immediately after recovery of the system and standard downcast plots were made. Data were compared to the measurements with the shipboard SBE 3-CTD (10 profiles were acquired, see station list) which was equipped with a chlorophyll fluorecence and two oxygen sensors. Salinity and temperature data fitted perfectly between the two CTD systems (Fig. 12). The oxygen values of the SBE-3 were slightly higher than of the SBE-19 profiler and fitted almost perfectly to measured oxygen values (Winkler titration performed by the ICCM, see above) (Fig. 12).

Table 7. List of CTD-O_2-chlorophyll-fluorescence profiles taken with the SBE-19 profiler.

GeoB station #	Date 2008	Time (UTC)	LAT N	LONG W	Water depth (m)	Deployment depth (m)
12907-3	20.04	21:49	21°16.9’	20°47.8’	4154	2000
12910-1	23.04.	07:43	20°43.3’	18°42.3’	Ca. 2700	2500
12911-3	23.04	20:59	20°04.7’	18°58.7’	Ca. 3012	2500
12913-1	24.04.	20:03	20°35.0’	18°00.0’	766	750
12914-4	25.04.	20:38	21°19.9’	18°49.7’	3062	2000

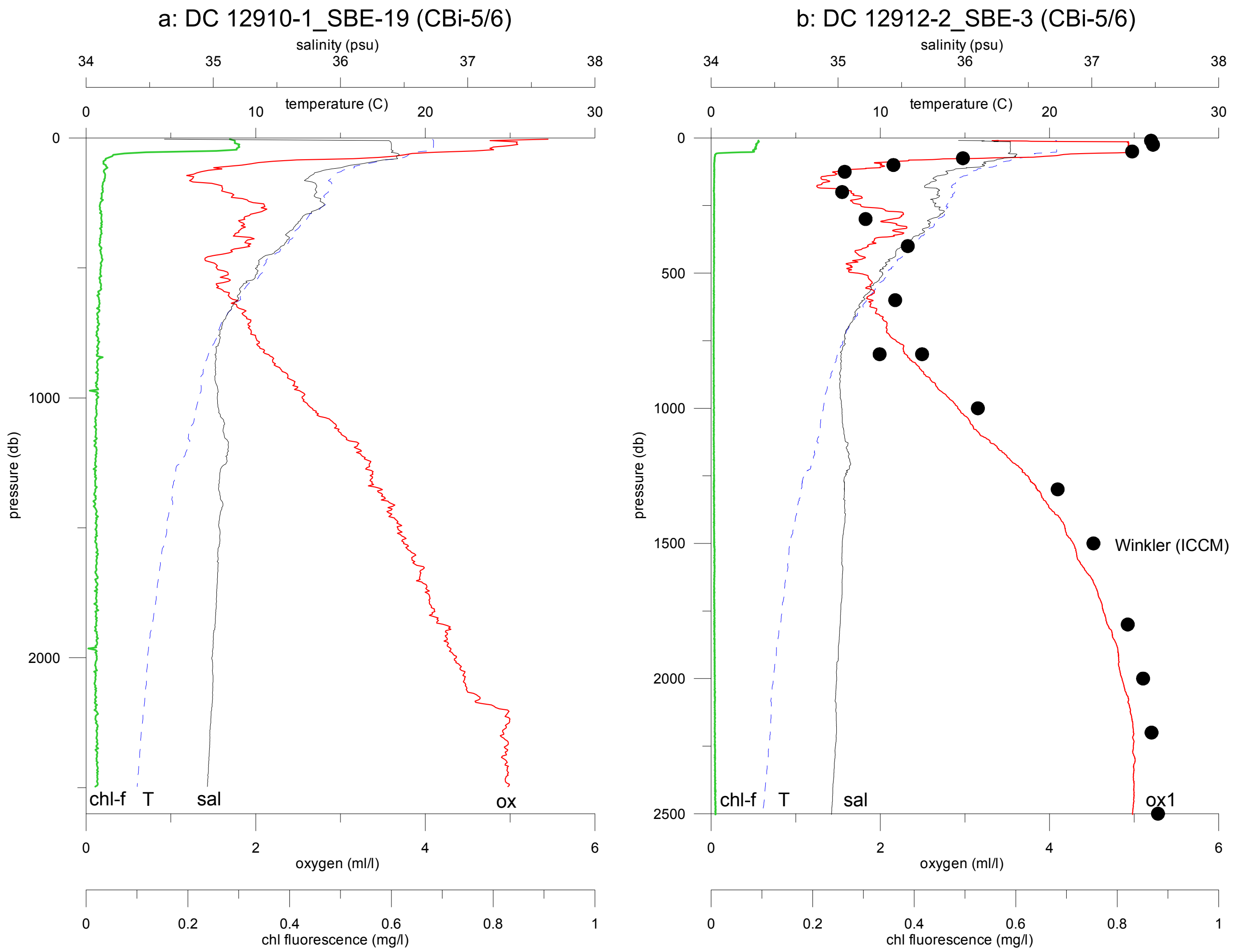


Fig. 12. Downcast CTD-profiles taken at the eutrophic mooring site CBi with the the SBE-19 (a: attached to the ParCa frame, see below) and the shipboard instrument SBE-3 (b). Oxygen from Winkler tritration (ICCM, see above) is also shown in b (black dots) and cooresponds nicely to the measured values. Note the good correspondance between the two instruments in S and T, chlorophyll fluoerescence, however, is too low in b (SBE-3).

2.4.2. Sampling for chlorophyll-a measurements *(M. Klann, G. Fischer)*

For the determination of chlorophyll-a concentrations in the surface waters, seawater from the shipboard installed seawater pump ("Aquariumpumpe") was sampled when sailing (Table 8). Half a liter or one liter of seawater were filtered onto a glass microfibre filter (Whatman, GF/F, 25 mm diameter). The samples were frozen at dark and will be analyzed by means of photometry at the laboratory in Bremen. The results from the samples from the shipboard pump will be compared with satellite-derived chlorophyll concentration maps (SeaWiFs, MODIS) and may serve as calibration of these data.

Table 8. Sampling for chlorophyll-a measurements (shipboard aquarium pump).T-S-data were taken from the ships' thermosalinograph.

Sample #	Date 2008	Time (UTC)	Latitude N	Longitude W	Water depth (m)	Salinity (‰)	SST (°C)	Volume (l)
1	20.04.	10:42	21°15.4262	20°49.2300	4154	35,13	20,77	2
2	20.04.	10:42	21°15.4262	20°49.2300	4154	35,13	20,77	2
3	22.04.	17:20	20°34.6920	18°00.102	770,3	34,67	17,16	2
4	22.04.	17:20	20°34.6920	18°00.102	770,3	34,67	17,16	2
5	23.04.	07:15	20°43.2708	18°42.3558	no data	35,07	20,31	2
6	23.04.	07:15	20°43.2708	18°42.3558	no data	35,07	20,31	2
7	23.04.	18:07	20°04.6860	18°58.7352	no data	34,62	19,12	1,5
8	23.04.	18:07	20°04.6860	18°58.7352	no data	34,62	19,12	1,5
9	24.04.	19:36	20°34.9920	18°00.0282	770	34,73	17,58	1,5
10	24.04.	19:36	20°34.9920	18°00.0282	770	34,73	17,58	1,5
11	25.04.	19:56	21°19.9212	18°48.6680	3060	35,15	19,81	1,5
12	25.04.	00:00	21°19.9212	18°48.6680	3060	35,15	19,81	1,2

2.4.3. Particle fluxes measured with sediment traps

(N. Nowald, C. Reuter, M. Klann, G. Fischer, G. Ruhland)

One aim of this part of the cruise was to recover and redeploy the moorings CI-21/22 (=ESTOC) located north of the Canary Islands in a mesotrophic/oligotrophic setting where sediment traps have been deployed since 1991. It was also planned to recover and redeploy mooring CB18/19 which is located about 200 nm off Cape Blanc (Mauritania, Fig. 1). This mesotrophic study site operated since 1988 is located at the edge of the Cape Blanc filament in about 4100 m water depth. It is used to monitor the long-term change of particle fluxes in the Mauritanian offshore upwelling zone. An additional mooring named CBi-5 was deployed during MERIAN MSM 04b cruise around 80 nm further to the east and was also planned to be exchanged (CBi-6, Fig. 1). The data of deployments and recoveries of the moorings are listed in Table 8 alongside with the sampling data of the traps.

On April 15th the mooring CI-21 equipped with 3 particle traps had been recovered successfully. All traps had worked perfectly, delivering 20 samples each. The mooring was redeployed in a comparable configuration in the afternoon of the same day as CI-22 at the same location (Fig. 13).

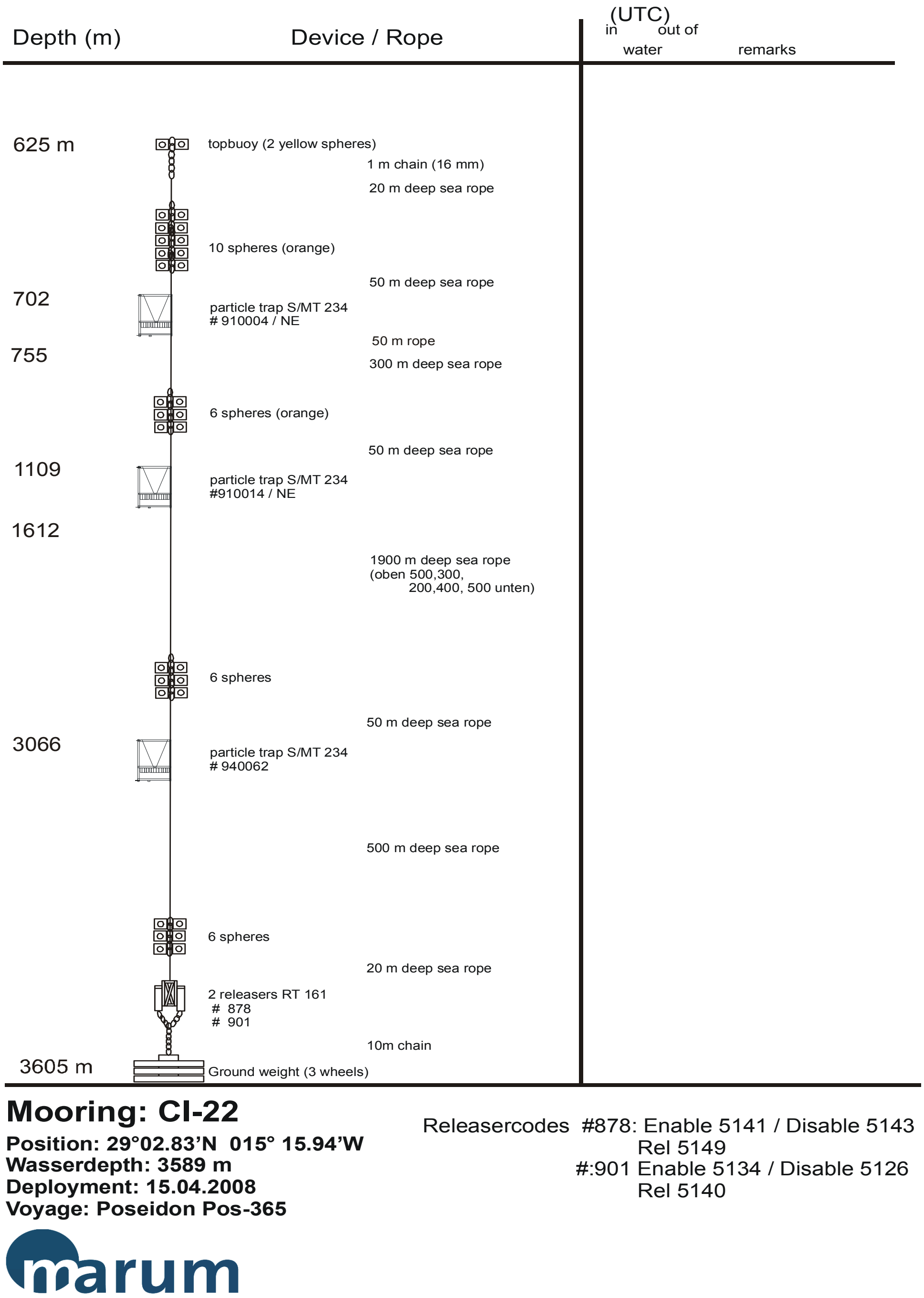


Fig. 13. Drawing of the ESTOC mooring CI-22 deployed north of the Canary Islands.

On April 20th, we successfully recovered mooring CB-18 ca. 200 nm off Cape Blanc which had worked perfectly. It was redeployed as CB-19 with a similar configuration on April 21. In the morning of April 23, we released the 1500 m long mooring array CBi-5 in the coastal part of the Cape Blanc filament which was equipped with two traps including one MSD trap with 40 cups and one current meter. We received one complete set of 40 samples of CBi-5 from the upper water column, the lower trap had failed. On April 24th, we could redeploy the mooring array CBi-6 (with a MSD trap of 40 cups), now equipped with a newly developed MSD platform with a FSI-CTD and a video camera system. The latter should monitor particle distribution and transport as well as particle sizes over an annual cycle. It is planned to recover and redeploy the mooring arrays with RV MERIAN in spring 2009.

Table 9. Data for recoveries and redeployments of the sediment trap mooring arrays.

Mooring	Position	Water Depth (m)	Interval	Instr. (m)	Depth (no x days)	Intervals
Mooring recoveries						
CI-21/ESTOC:	29°02.6'N	3605	22.03.07-	SMT 234	702	20 x 19
	15°15.7.W		05.04.08	SMT 234	1109	20 x 19
				SMT 234	3066	20 x 19
Cape Blanc mesotrophic:						
CB-18	21°16,9' N	4168	25.03.07-	SMT 243	1222	20 x 19
	20°48,0' W		05.04.08	SMT 234	3629	20 x 19
Cape Blanc eutrophic:						
CBi-5	20°44.9' N	2709	28.03.07-	MSD	1263	38 x 9,5, 2 x 6,5
	18°41.9' W		05.04.08	SMT 234	1872	20 x 19
				RCM8	1317	
Mooring deployments:						
CI-22/ESTOC:	29°02.8'N	3605	16.04.08-	SMT 234 NE	702	20 x 17
	15°15.9.W		22.03.09	SMT 234 NE	1109	20 x 17
				SMT 234	3066	20 x 17
Cape Blanc mesotrophic:						
CB-19	21°16,2' N	4155	22.04.08-	SMT 230Ti NE	1209	1 x 11, 19 x 17
	20°48,7' W		22.03.09	SMT 238	3617	20 x 17
Cape Blanc eutrophic:						
CBi-6	20°45.1' N	2699	25.04.08-	MSD platfrom	1189	
	18°41.9' W		22.03.09	MSD trap	1299	2 x 4, 38 x 8,5
				SMT 243 Ti NE	1869	1 x 8, 19 x 17

Instruments used:

SMT 230/241/243/234 = Sediment trap (Ti=Titanium trap), Aquatec Meerestechnik, Kiel

RCM 8 = Aanderaa current meter, RCM 8

SMT 230/234/238 NE = new electronics

MSD = Mult-Sensor-Device trap with 40 cups

MSD platfrom = platform with FSI-CTD and video camera

2.4.4. Particle distribution measured with optical systems (ParCa)

(N. Nowald, C. Reuter, M. Klann)

System description

The photographic particle camera system ParCa was deployed on 5 locations for the in-situ measurement of the vertical size distribution and concentration of particulate matter in the ocean ('*marine snow*'). ParCa consists of a modified NIKON CoolPix 995 digital camera. A strobe, mounted perpendicular to the optical axis of the camera, provides a collimated light beam of 12 cm width, illuminating a defined sample volume. Power Source is a 24V/38 Ah rechargeable lead battery designed for the use to full ocean depth. ParCa can operate in depths up to 3000 m. All devices are mounted in a 200 kg galvanised frame. Communication with the ship is done by a microcontroller and adapted software. An additionally installed SeaBird PDIM telemetry provides full control of the entire system, via the ships coaxial wire. Pictures were exposed while lowering the system at a speed of 0.5 m/sec at approx. each 12 m of depth. A detailed station list is given below (Table 10).

Table 10. List of stations done with the ParCa system combined with the SBE 19-CTD.

GeoB #	**Date 2008**	**Time seafloor/ max. wire –length (UTC)**	**Latitude**	**Longitude**	**Water depth (m)**	**Deployment depth**
12907	20.04.	09:45	21°16.9 N	20°47.8 W	4152	Down to 2000
12910	23.04.	06:30	20°43.3 N	18°42.3 W	~2650	Down to 2500m
12911	23.04.	19:30	20°04.7 N	18°58.7 W	3016	Down to 2500m
12913	24.04.	?	20°35.0 N	18°00.0 W	766	Down to 750m
12914	25.04.	19:40	21°19.9 N	18°49.6 W	3062	Down to 2000m

Preliminary results

Although a distinct surface maximum is found everywhere, concentrations vary in the upper ocean surface between the different stations (around 100 and 300 particles per image) (Fig. 14). Below the euphotic zone, the distribution of particulate matter is highly variable. Some characteristic distribution patterns, repeatedly observed in this area, were also found during this cruise. Station GeoB 12911, shows an extensive subsurface particle maximum around 300 m water depth. This kind of particle distribution is common off Cape Blanc and is found in many particle profiles aqcuired in this area. The same is true or the distinct deep water maximum (1500 m – 2200 m) at station GeoB 12910 (CBi trap mooring site). This characteristic maximum was tracked for three years up to now at this specific site and appears to be a common feature.

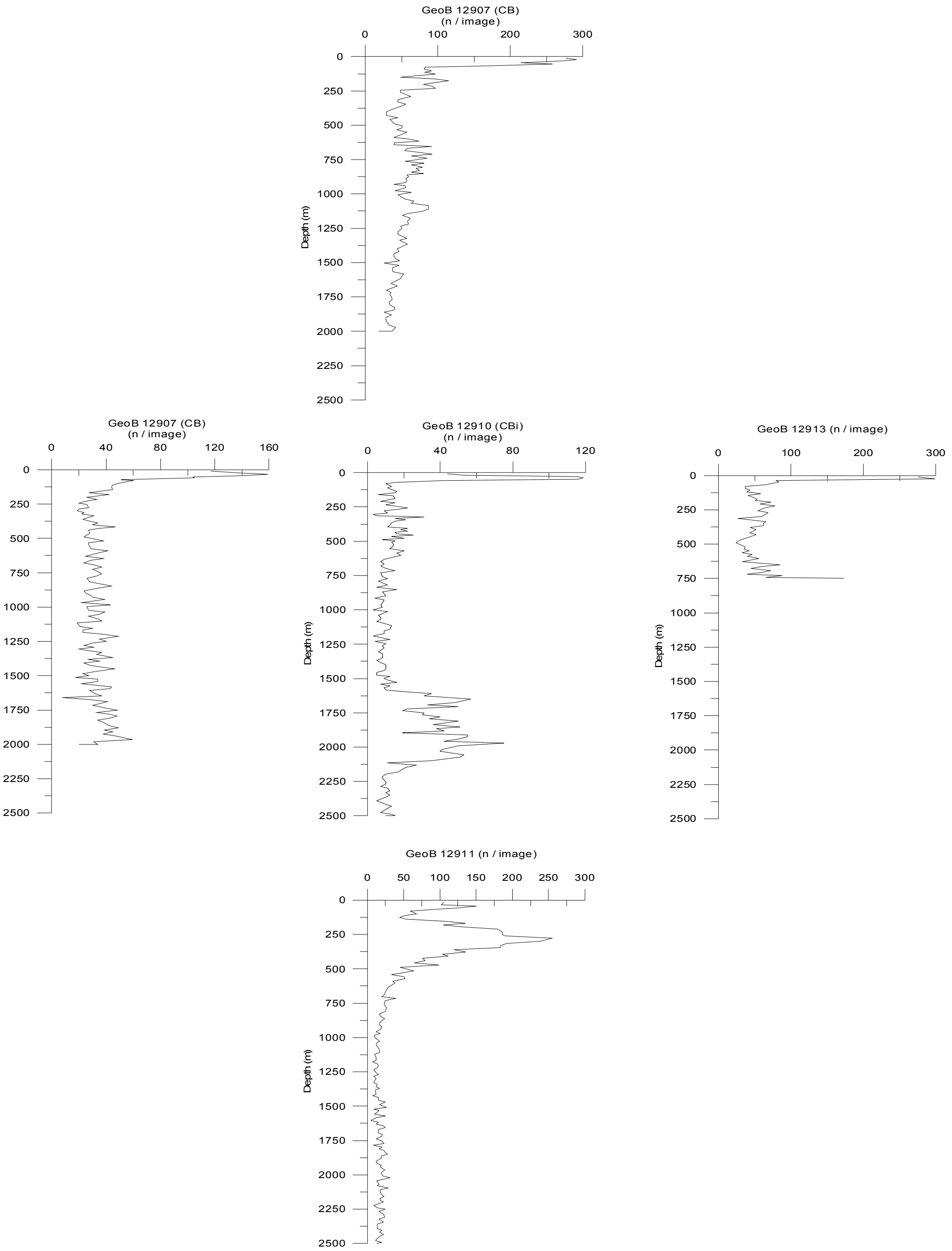


Fig. 14. Abundances of particles as number per image in the water column off Cape Blanc as derived from the ParCa system.

2.4.5. Particle investigations with the ROV *Cherokee*

(N. Nowald, C. Reuter, G. Ruhland, M. Klann, E. Kopiske)

System description

The Remotely Operated Vehicle (ROV) *Cherokee* is a commercially available, midsize inspection class ROV, manufactured by *Sub-Atlantic*, Aberdeen. It is operated by MARUM since 2001 and was adapted and enhanced for scientific purposes. The vehicle was involved in many different research programs and cruises, performing more than 75 dives up to now.

The *Cherokee* ROV system consists of three major components: a spooling winch, the Surface Control Racks and the vehicle itself. Vehicle dimensions are 120x80x100 cm (LxBxH) and weight in air is around 450 kg. The *Cherokee* has a payload for scientific equipment of approx. 20 kg. The ROV is electrically propelled by 4 axial thrusters and total power of the system is 12 kW. *Cherokee* is 1000m depth rated, but due to several "cut offs" and terminations of the umbilical supply cable, only a diving depth of 850 m is guaranteed. Four video cameras are mounted on the ROV for observation and navigational purposes. A color video zoom camera (720x576 lines), a modified digital Nikon still camera (3.2 Megapixel) with associated flash light and two mini video cameras for the overview to the front and back area of the vehicle. The video-, and the still image camera are mounted onto a Pan & Tilt unit, which enhances the observation capabilities of the vehicle. The Pan & Tilt unit also carries 3 lasers for object size measurements on the seafloor. Underwater light is provided by 3x230W *DSPL* dimmable spots. For long or close range obstacle detection and measurement, a *Tritech Seaking* dual frequency sonar is mounted on the port side of the vehicle. It displays an accoustical realtime image on the topside sonar PC. The sonar operates at 325/675 Hz with a maximum scanning range of 300 m. Sonar screenshots and recordings are possible. Navigational devices such as compass, altimeter and depth sensor, are part of the basic sensor package onboard the ROV.

For scientific sampling and experiments, a small hydraulic manipulator system is used. The *Hydro-Lek* HLK-EH-5 is a non-proportional, 5 function manipulator, powered and controlled by a combined pressure pump and 6 station valve pack. Operating pressure is 130 bar and lifting capacity is 25 kg. Part of the hydraulical system is the toolbox, which is used for storing samples and/or mounting sampling tools. It can be hydraulically opened and closed. Standard sampling tools during RV PELAGIA cruise 64PE284 were a 1 l Niskin bottle and a sampling net with a diameter of 140 mm and a mesh size of 1 mm. The supply cable (Umbilical) contains 20 electrical conductors providing electrical power and basic telemetry. In addition, 4 optical multimode fibres provide 4 video and 4xRS232 channels.

Control over the system is given by three 19" racks, equipped with several display and recording devices. The *Surface Control Unit* contains the remote control for the vehicle and the manipulator. It also contains the sonar PC and screen, two small 10" color monitors for video camera display as well as an ampere-, and voltmeter. The *Pilot Rack*´s PC monitor shows navigational data from the ship and the ROV, such as heading, position, depth and so on. A large analogue monitor inside the rack displays the live video of the *Tritech* color zoom camera. The V*ideo Rack* includes 2 DV recorders to record two cameras simoultaneously. The rack also has a PC with software running to control the *Nikon* still image camera, the *Ifremer* framegrab utility *Adelie and* the USBL positioning system GAPS (*IXSEA*).

Scientific payload

The vehicle was equipped with a *Settling Chamber* in order to measure sinking velocities of marine particles in different water depths (Fig. 15). The box is made of *Plexiglas* and its dimensions are 30x60x30 cm (LxBxH). It can be opened and closed sideways, with aid of the ROV´s manipulator. For accurate measurements, a collimated light source providing a slab of light of 12 cm width, is mounted on the port side of the vehicle. A caliper fixed in the middle of the slab of light, helps in measuring the distance a particle travelled through time within the closed box and calculating the total sample volume. During the cruise, the vehicle was deployed at station GeoB 12907. Recordings of sinking material were acquired in four different depths (50 m, 150 m, 250 m, 400 m). The video recordings will be analysed at the University of Bremen.

Fig. 15. The *Settling Chamber* mounted in front of the ROV *Cherokee*.

2.5. Marine Techology

2.5.1. Recovery of the DOLAN buoy

(G. Ruhland, E. Kopiske, S. Klar, K. Dehning, C. Reuter)

The Surface Buoy Unit (SBU) operates since 1997 and was formerly part of the DOMEST project, later it was used in the MERSEA project. The unit can carry several meteorological sensors, satellite telemetry links and sub-sea telemetry links like an ORCA acoustic modem as well as a cable telemetry down to 100 m. Due to the end of the project, the buoy was recovered but not redeployed. The recovery has been done on April 14th without any problems and all sensors and the buoy itself were in a good condition. The last configuration of the system is shown in Figure 16.

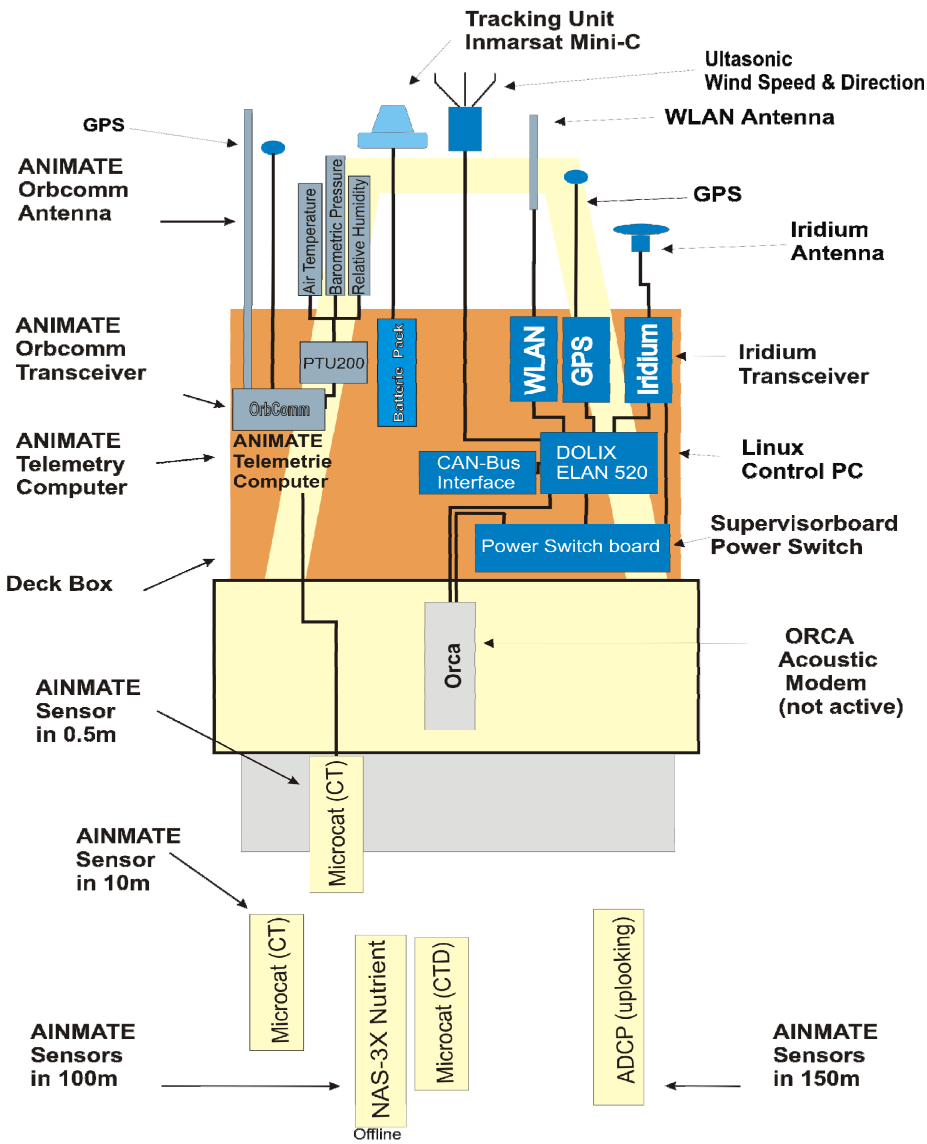


Fig. 16. Configuration of the Surface Buoy Unit (SBU) in the last deployment interval.

Additionally to the usually used equipment an underwater modem was installed to establish an hourly acoustic communication link to the nearby placed PACT mooring.

2.5.2. Recovery of the PACT mooring

(G. Ruhland, E. Kopiske, S. Klar, K. Dehning, C. Reuter)

In a distance of about one nautical mile to the SBU, a mooring was deployed on POS360 which was used for trials of PACT (Pressure Acoustically Coupled Tsunameter) units. The bottom unit of the PACT system which monitored changes in pressure was installed in a water depth of 3600 m. The HAM.Node receiver modem was mounted to the SBU mooring in 12 m depth and connected to an IRIDIUM satellite transceiver residing on top of the buoy. Data received from the PACT bottom unit was relayed to the AWI/Bremerhaven via a satellite link. The satellite link also provides basic diagnostic functionality (like pinging the bottom unit, information about battery status etc.). Figure 17 shows the complete series of messages which were sent during the test interval. Usually one message per hour was transmitted to save battery power. In between simulated tsunami alarms triggered a higher rate of transmissions.

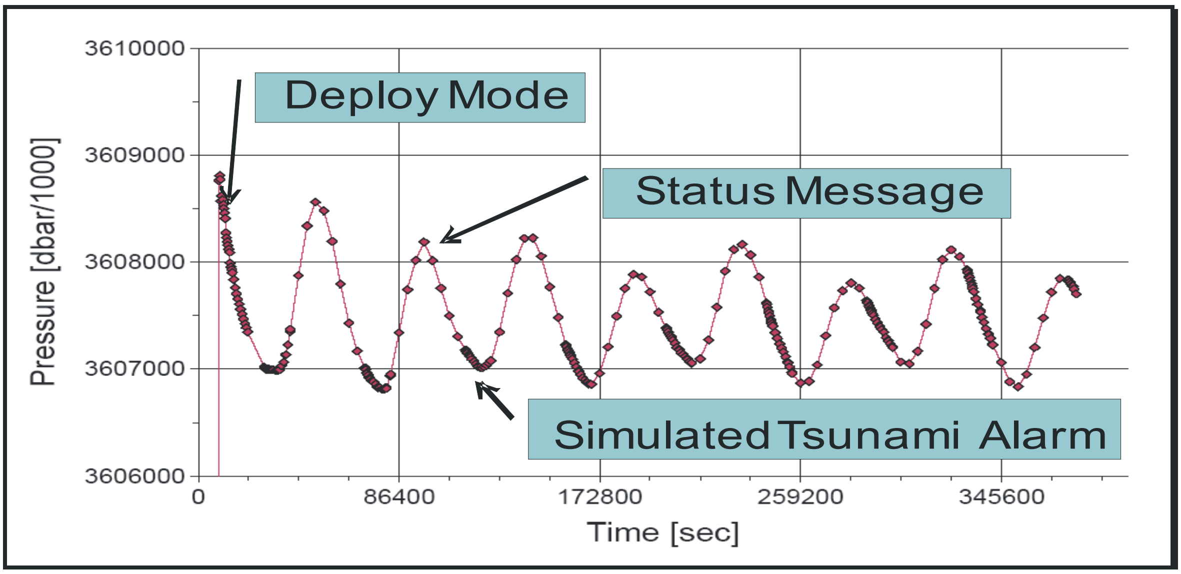


Fig. 17. Pressure data telegrams as hourly routine and simulated tsunami alarm messages.

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2.7. Acknowledgements

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3. Station List (POS 365 Leg 1 and 2)

GeoB #	**Ships #**	**Date 2008**	**Device**	**Time seafloor/ max. wire -length [UTC]**	**Latitude N**	**Longitude W**	**Water depth [m]**	**Recovery/Remarks**
365-1								
12901-1	212	13.04.	PACT	16:35	29°11.48'	15°54.99'	3630	Recovery of PACT mooring, release
12901-2	212-2		ROS-CTD	19:12	29°11.48'	15°56.02'	3630	Down to 1000m: casts at 1000,200,150,100,90,80,70,55,40,25,10 m
12902-1	213	14.04.	DOLAN	07:14	29°10.89'	15°55.01'	3628	Recovery of DOLAN buoy started
12902-2	214		XBT	12:26	29°13.97'	15°53.69'	3630	Down to 1830m
12903-1	215		ROS-CTD	17:30	29°10.06'	15°20.00'	3595	Down to 3500m: casts at 3500,3000,2800,2500,2000,1800,1500,1300, 1200,1100,1000,800 m
12904-1	216	15.04	ESTOC-CI	07:06	29°02.55'	15°15.71'	3589	Recovery of mooring, 3 traps worked
12905-1	217		ROS-CTD	11:54	29°09.99'	15°20.03'	3594	Down to 800m: casts at: 800,600,400,300,200,150,125,100,75,50,25,10 m
12905-2	217-2		NOAA	12:23	29°10.01'	15°20.03'	3595	Deployment of NOAA drifter
12906-1	218		ESTOC-CI-22	17:00	29°02.83'	15°15.94'	3589	Deployment of ESTOC-CI-22 mooring with 3 traps
365-2								
12907-1	226	20.04.	CB-18	14:31	21°16.50'	20°48.39'	4156	Both traps worked
12907-2	227		ROS-CTD	19:23	21°16.87'	20°48.11'	4156	Down to 800m: casts at: 800,600,400,300,200,150,125,100,75,50,25,10 m
12907-3	227-2		Parca-CTD	21:49	21°16.86'	20°47.83'	4154	Down to 2000m
12907-4	228	21.04.	ROS-CTD	05:51	21°16.79'	20°47.97'	4159	Down to 2000m casts at: 2000(2x),1800,1600,1400,1200, 1000,800,500(2x),35(2x) m
12907-5	229	.	CB-19	07:54	21°14.04'	20°50.55'	4238	Start deployment
12908-1	230		XBT	19:52	20°59.97'	19°40.47'	3639	Down to 1800m
12909-1	231	22.04.	ROS-CTD	17:48	20°34.91'	18°00.11'	768	Down to 700m Casts at: 700(2x),600,400(2x),300,200,100,50, 35(2x), 10 m
12910-1	232	23.04.	Parca-CTD	07:43	20°43.25'	18°42.31'	Ca.2700	Down to 2500m
12910-2	233		CBi-5	09:05	20°44.59'	18°41.99'	Ca.2700	mooring released, MSD at #40, lower trap failed

GeoB #	Ships #	Date 2008	Device	Time seafloor/ max. wire -length [UTC]	Latitude N	Longitude W	Water depth [m]	Recovery/Remarks
12911-1	234		XBT	17:40	20°03.62’	18°59.39’	3013	Down to 1800m
12911-2	234-2		ROS-CTD	18:20	20°04.66’	18°58.74’	3012	Down to 800m Casts at: 00,600,400,300,200,150,125,100,75,50,25,10 m
12911-3	234-3		Parca-CTD	20:59	20°04.70’	18°58.71’	Ca.3012	Down to 2500m
12912-1	235	24.04.	ROS-CTD	07:24	20°44.97’	18°41.95’	2721	Down to 800m Casts at:800,600,400,300,200,150,125,100,75,50,25,10 m
12912-2	235-2		ROS-CTD	09:09	20°44.98’	18°41.98’	Ca.2721	Down to 2500m Casts at: 2500(2x),2200,2000,1800(2x),1500,1300,1000 800,75(2x) m
12912-3	235-3		CBi-6	12:00	20°44.13’	18°42.16’	2700	Start of deployment
12913-1	236		Parca-CTD	20:03	20°34.99’	18°00.01’	766	Down to 750m
12914-1	237	25.04.	XBT	11:53	21°18.63’	18°49.61’	3054	Down to 1800m
12914-2	238		ROV	12.23	21°20.11’	18°49.89’	3061	Deployment, down to 400m; with nutrient sensor
12914-3	238-2		ROS-CTD	18:59	21°19.82’	18°49.59’	3059	Down to 800m casts at: 800,600,400,300,200,150,125,100,75,50,25,10 m
12914-4	238-3		Parca-CTD	20:38	21°19.91’	18°49.66’	3062	Down to 2000m

CI (ESTOC), CB, CBi - Sediment trap mooring sites north of Gran Canaria (CI/ESTOC) and off Cape Blanc (Mauritania)

ROS-CTD – Multi-water sampler (rosette) with 12x10l bottles and CTD-SBE 3 (IFM-GEOMAR)

PARCA-CTD– Particle Camera System with CTD SBE 19 inside frame (CTD-O_2- chlorophyll-fluoerscence (SBE-19, #2069)

ROV – Cherokee, with nitrate sensor and settling chamber

PACT – tsunameter mooring

DOLAN – instrument bouy

XBT – extended bathythermograph

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